Advanced Nuclear Fuel Cycle Program

Quarterly Review Meeting

TRISO Fuel Development Status

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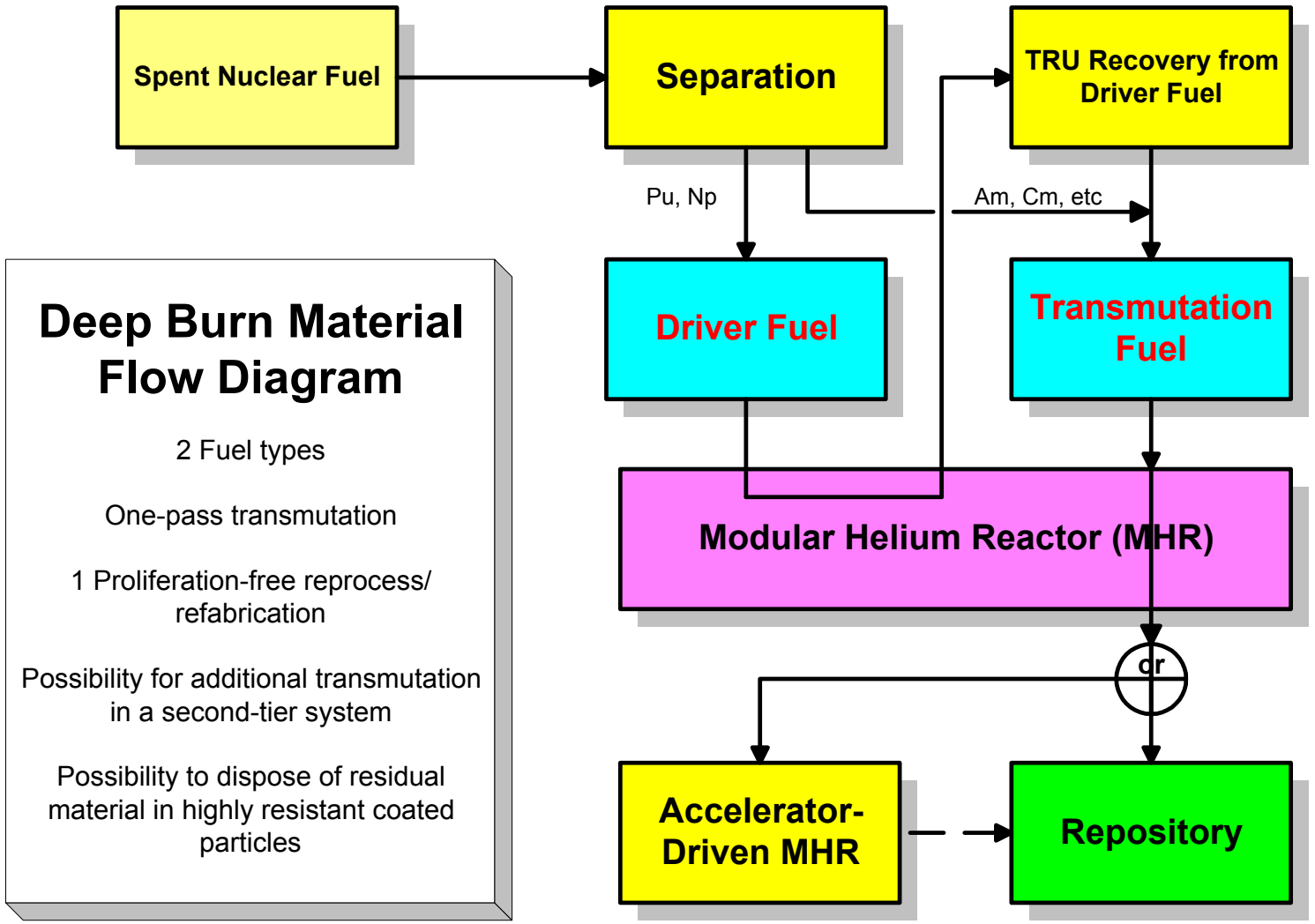
Albuquerque NM

AFC
ADVANCED FUEL
CYCLE INITIATIVE

1. BACKGROUND

GA Deep Burn Transmutation Integrates Series I and II



Deep Burn Material Flow Diagram

2 Fuel types

One-pass transmutation

1 Proliferation-free reprocess/ refabrication

Possibility for additional transmutation in a second-tier system

Possibility to dispose of residual material in highly resistant coated particles

- other deployment options possible

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Deep Burn Fuel Plan Integrated AFC Goals with NP-2010

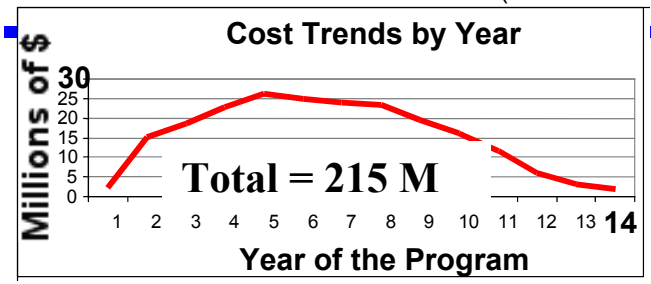
Fiscal Year																
02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	...	23

Fuel Fabrication Demonstration
(Multicell Screening Tests)

Driver Fuel (DF) Qualification
(Proof of Principle, Performance Tests)

Transmutation Fuel (TF) Qualification
(Proof of Principle, P erformance Tests)

LWR TRU Waste TRISO Fuel Development Program



Fuel Validation Tests
(Prototype Element Tests)

Scaleable Element Production

Demonstrator Construction

MHR Development Program

Demonstrator Testing, Operation
(U fuel base + DF, TF, other production test elements)

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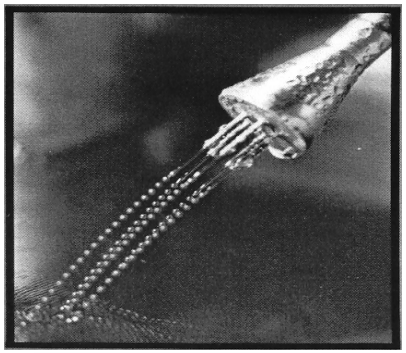
2. STATUS REPORT

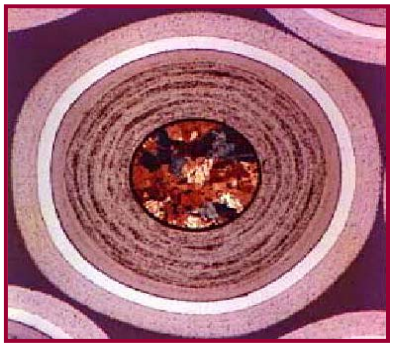
Transmutation Fuel Process Parallels Established Uranium Fuel Fabrication

Kernels by Gel-Precip.

Coating by CVD

Compaction by Compression Molding





Kernel | **Coating** | **Compact**

Nature		Similar to U-process	Similar to U-Process	Identical to U-process
State of Develop	Pu	Lab-scale	(add ZrC)	_____
	Am-Cm	Related work (resin-loading)	(add ZrC)	_____

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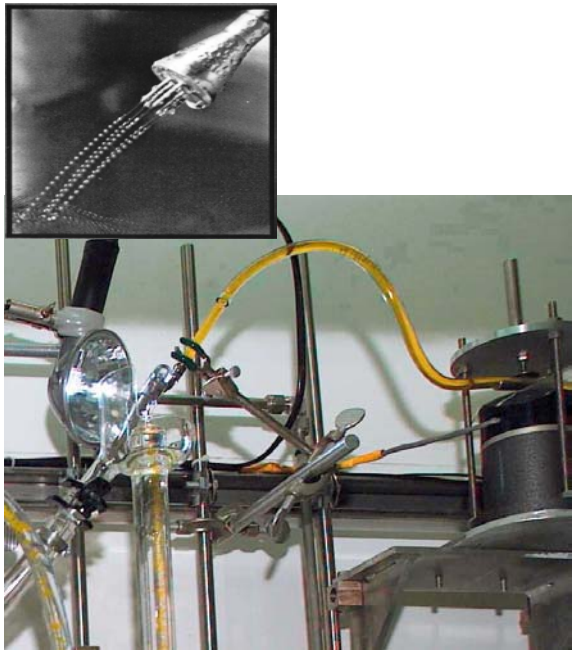
Coating and Kernel Labs Established



FY02: Uranium Kernels | Surrogate Coating | U-Coating

Development Path

Surrogate --> Uranium --> Pu/Np --> Am/Cm

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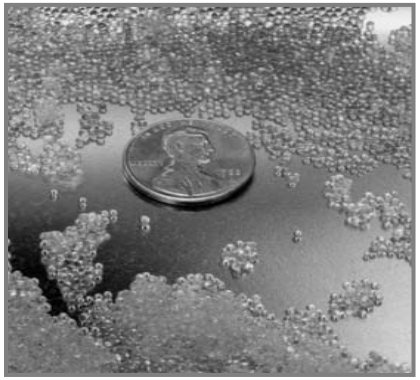
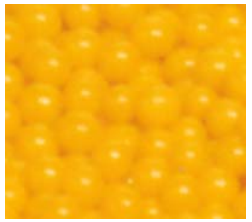
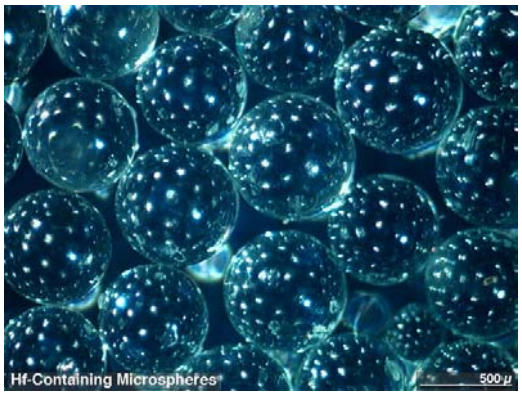
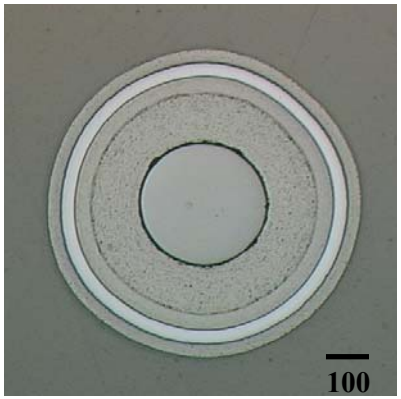
Uranium Kernels and Surrogate TRISO made to Re-establish Fuel Fabrication Standards



960 µm wet

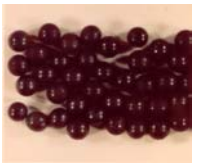






610 µm dry

300 µm sintered



FY02: **HfO_2 for dense kernels**

ZrO_2 SiC-TRISO (HfO2 also coated)

UO_2 kernels

1 kg produced (new synthesis)

30 coating runs

1 kg produced

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Fuel Design Review Concludes:

No Chemical Barriers for Pu-Np-Am Fuels ORNL/TM-2002/133

- **Am-volatility is low enough for oxide fabrication.**

- **ZrC probably needed for Deep Burn Transmutation:**

ZrC barrier layer to resist "noble metal" attack:

Pd, Ag have much higher yields for MA (> 10X U-235)
ZrC is more resistant to Pd-attack than SiC
Higher temperature, burnup releases more Ag/Pd from kernel

ZrC in the buffer layer prevents CO generation:

lowers gas pressure - important for high burnup
prevents kernel migration coating failure
ZrC buffer layer demonstrated in UO_2* design

ZrC is much more refractory than SiC

ZrC Coating is likely needed for Higher Temperature GENIV Applications

TRU activities: Kernels Lab and Resin-loading

- Electrolytic dissolution and solution preparation established in existing gloveboxes.
- TRU materials processed for dispersion fuel:
  - 50 grams of Am converted to resin-loaded kernels in TRU hotcells
  - 70 grams of Pu/Np dissolved
- Dispersion Fuel Activity halted in September

3. 5-Year Strategy

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TRISO 5-Year Plan Must Accommodate Change

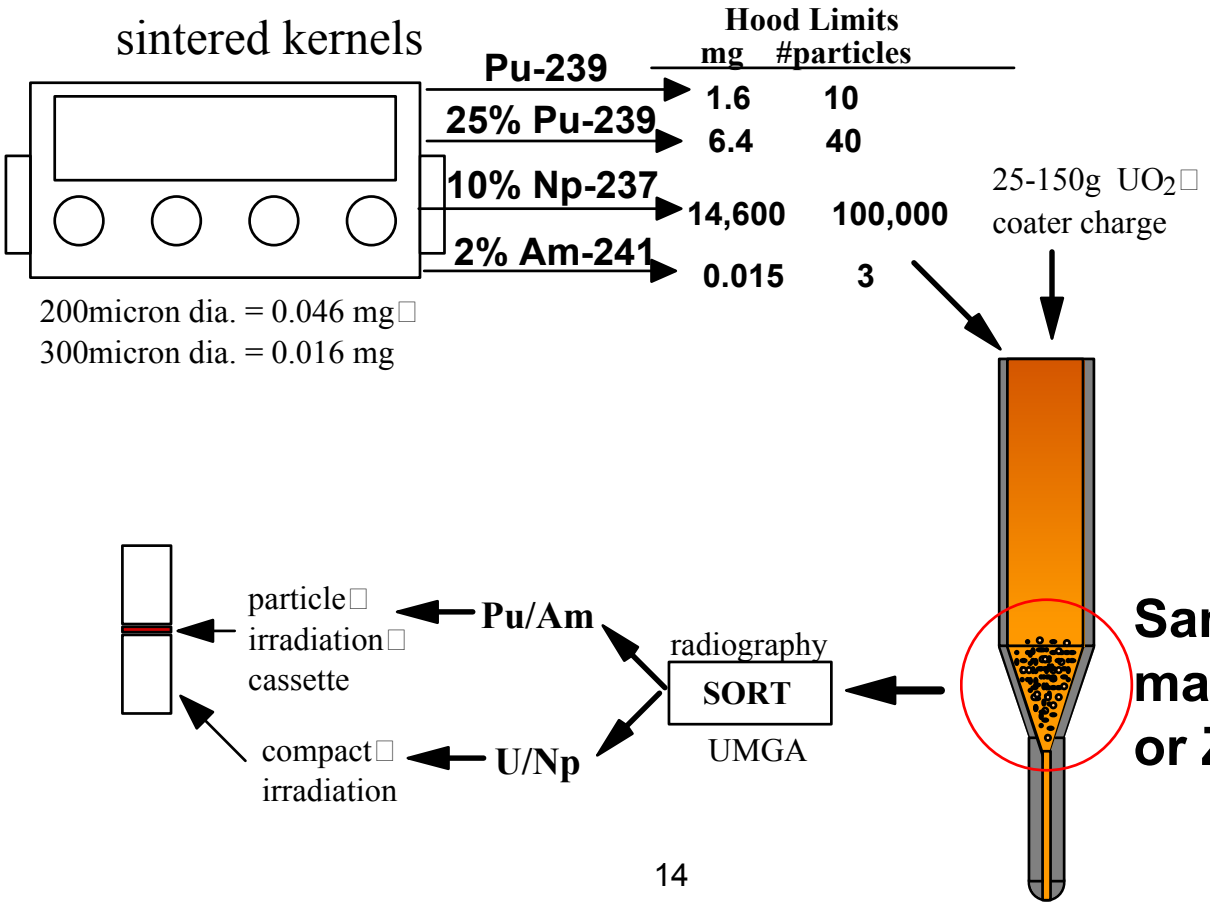
- **Funds for R&D are limited**
  - **remote and high-alpha work is expensive**
  - **TRISO fuel fabrication is relatively complex**
- **VHTR, not NP-2010, is the relevant technology partner**
  - **There is a need to coordinate with GENIV and AGR**
  - **There is a need to coordinate with the Int'l Community**
- **A staged development is needed to meet AFC goals:**
  - **These recent changes require a different technical strategy**

Technical Strategy –

- Complete high-alpha kernel line for Pu/Np, and use in conjunction with existing radiochemical labs.
- Kernel: use simple oxides - works for all actinides, removes cost for development of oxy-carbides
- Coatings: work on ZrC
  - first as a getter layer
  - then as a barrier layer (to replace ZrC).
- Use out-or-reactor tests to screen candidates

Experimental Strategy – "Doing more with less (1)"

Sparse TRISO: seeded fabrication of TRISO by addition of small amounts of TRU to the coater charge

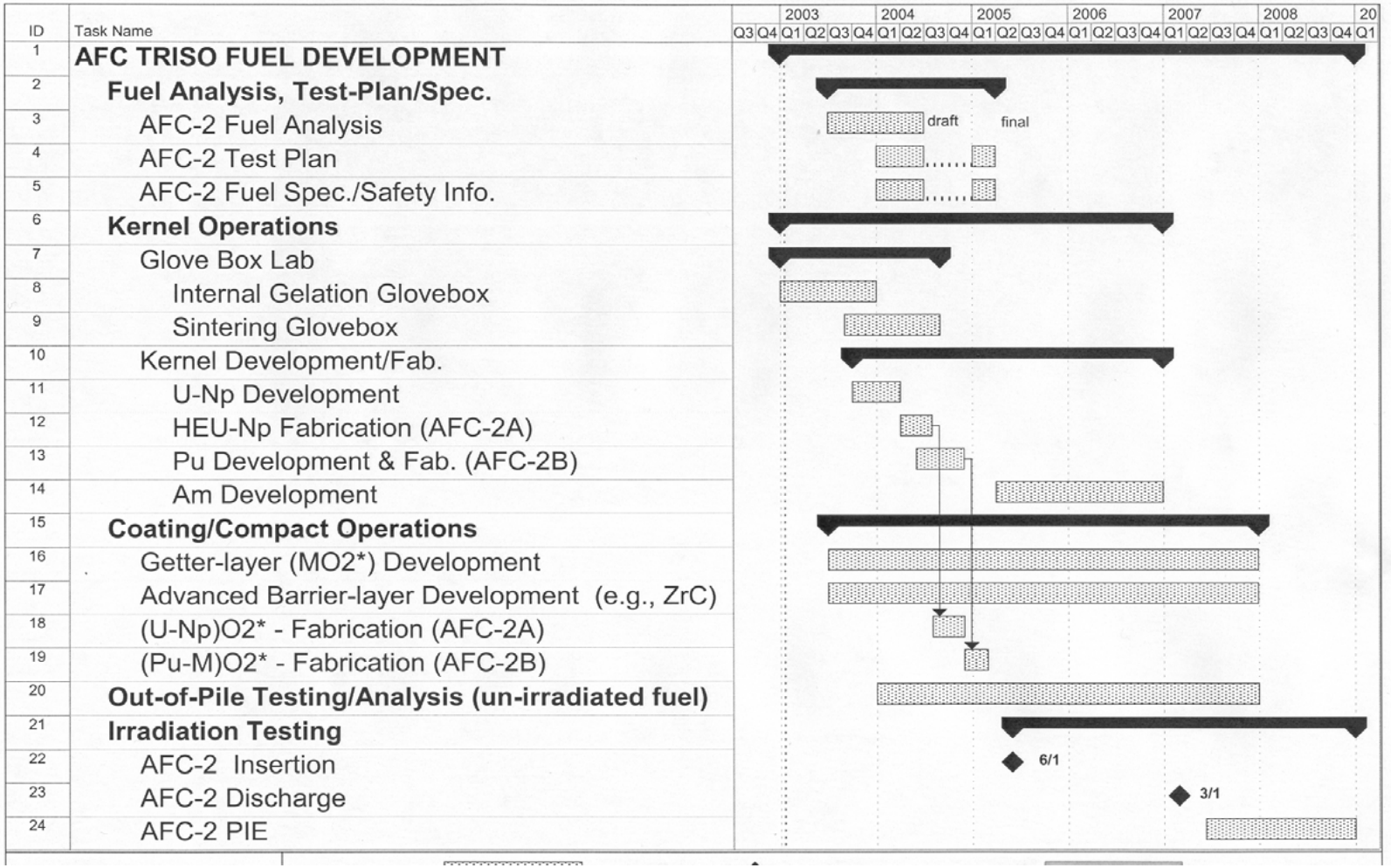


Same basic equip. makes either SiC- or ZrC-TRISO

“Doing more with less (2)”

- **Use multicell capsule, compacting, and fuel characterization capability being developed by the AGR program**
- **Coordinate Irradiation and PIE with ongoing DOE activities (AGR, NERI, VHTR)**
- **Explore Opportunities for International Collaboration (GIF)**

Draft Schedule Meets 2007 Evaluation Requirement



ID	Task Name
1	**AFC TRISO FUEL DEVELOPMENT**
2	**Fuel Analysis, Test-Plan/Spec.**
3	AFC-2 Fuel Analysis
4	AFC-2 Test Plan
5	AFC-2 Fuel Spec./Safety Info.
6	**Kernel Operations**
7	Glove Box Lab
8	Internal Gelation Glovebox
9	Sintering Glovebox
10	Kernel Development/Fab.
11	U-Np Development
12	HEU-Np Fabrication (AFC-2A)
13	Pu Development & Fab. (AFC-2B)
14	Am Development
15	**Coating/Compact Operations**
16	Getter-layer (MO2*) Development
17	Advanced Barrier-layer Development (e.g., ZrC)
18	(U-Np)O2* - Fabrication (AFC-2A)
19	(Pu-M)O2* - Fabrication (AFC-2B)
20	**Out-of-Pile Testing/Analysis (un-irradiated fuel)**
21	**Irradiation Testing**
22	AFC-2 Insertion
23	AFC-2 Discharge
24	AFC-2 PIE

4. FY03 Plans

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FY03 Scope Centers on Advanced Coatings

- **Major activity is Advanced Coatings — focus is on ZrC**

  (a) a getter layer
  (b) a barrier layer

- **Work on Kernels will include synthesis to make Uranium Carbides and Nitrides for I-NERI**

- **Work on Fuel Characterization is primarily to support work with ZrC**

- **Work on Fuel Materials Analysis is to support out-of-reactor test-planning, and fuel development planning**

Proposed FY03 Milestones in Review

- Fabricate uranium carbide and nitride kernels for out-of-reactor evaluation
- Fabricate TRISO coated particles with advanced coatings (ZrC) for out-of-reactor evaluation
- Fuel Characterization Requirements Report
- Advanced Coating Characterization Report
- Experimental Plan for Out-of-Reactor Investigations
- Completion/Stabilization of TRU glovebox activities